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(56) Documents Cited
GB 2281863 A **GB 2274334 A** **GB 2204874 A**
EP 0111093 A2 **WO 95/19142 A1** **US 4971068 A**
US 4509532 A

(58) Field of Search
UK CL (Edition Q) **A5R RHAP RHCE RHEPX , G1D DH31A DH31X , G1N NENT**
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(54) Abstract Title
Sensing and indicating temperature

(57) An electrode assembly, which may be used for surgical diathermy, includes looped wires 1,2,3 soldered 7 to a conductive sheet 5 backed by an insulating sheet 6. The conductive sheet 5 is coated with temperature-indicating paint or material of known infra-red emissivity, so as to give an indication of the temperature of tissue into which the wires 2,3 are inserted. The sheet also carries an angular position indicator 8. An insulating shield may be arranged parallel to the sensing wires.

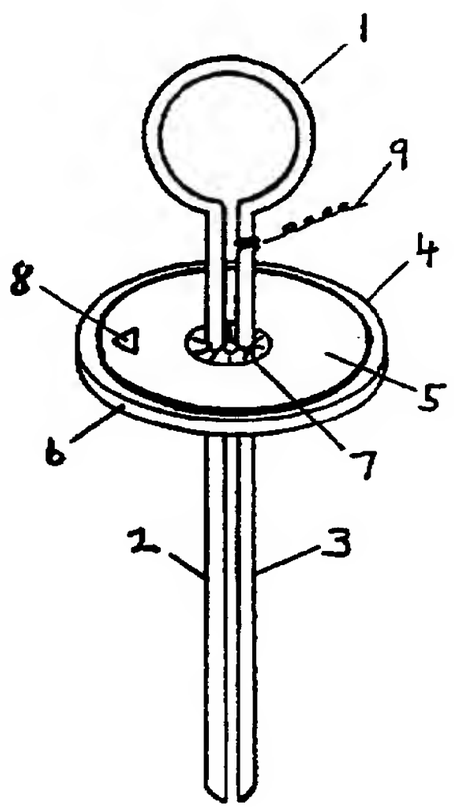

FIGURE 1

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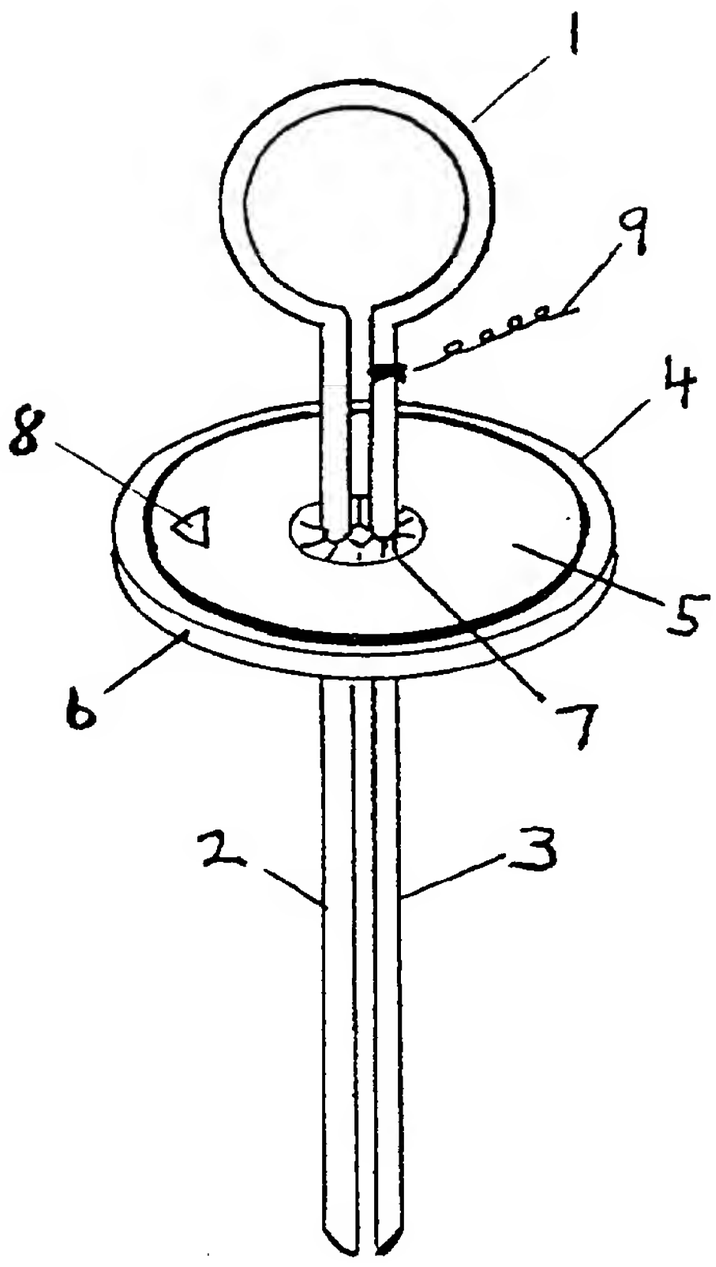

FIGURE 1

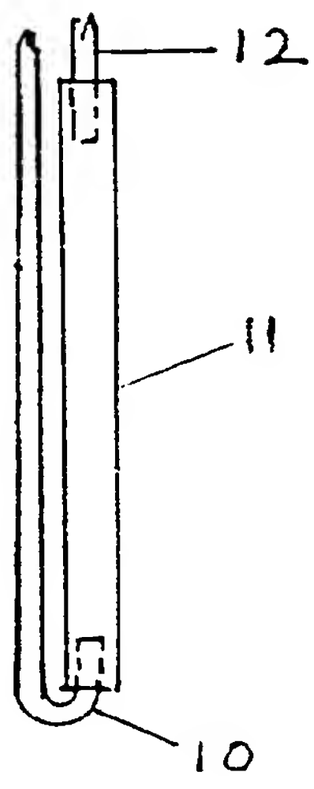

FIGURE 2

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IMPROVEMENTS IN RELATION TO TEMPERATURE SENSING

Methods exist for measuring the temperature of living tissue, one example being the clinical thermometer. Another method uses the electrical resistance thermometer whereby a sensing bead contains an electrically conducting element whose resistance varies with temperature, said bead being inserted within said living tissue and connected by wires to resistance measurement means which in a simple form could be a battery in series with a milliammeter.

Extensions of this principle allow multiple sensing elements to be inserted within living tissue, and using methods known in the prior art the temperature at each location can be ascertained. One application for such temperature sensing is the practice of surgical diathermy, whereby high frequency electric currents are passed through living tissue. Such currents may be used to cause a localised temperature rise intended to degrade infections or tumour cells. It is desirable to monitor the temperatures thus produced in order to control the progress of the treatment and guard against undue damage being caused to healthy tissue.

In my patent application no. GB2281863, polyphase currents pass through a plurality of conductive electrodes which are inserted into living tissue, surrounding an infected region or tumour, and connected to respective output terminals of a polyphase electrical generator operating at a frequency higher than 200KHz.

Temperature sensors, introduced into said tissue wherein diathermy is in progress, will however not only be costly but will disturb the current pattern and cause mechanical damage to said tissue. In addition, measurements made while strong high frequency voltages and currents are present for heating purposes will be disturbed by attendant electric and magnetic fields, so that indicated temperatures are likely to be in error. Precautions against such error must be provided.

Other techniques of temperature measurement can be used on the outer surface of a heated body, such as temperature sensitive paint and scanning by an infrared sensor, but if used on living tissue would give rise to error. This is because of factors such as evaporation of moisture, which can create a pronounced temperature gradient between an outer surface and internal regions of said heated body.

One remedy for such problems would involve transferring a temperature equal to that in the interior of a heated body to the exterior of said body. Preferably this would be done using the electrodes themselves, whereby said temperature could be validly measured by temperature sensitive paint or infrared sensing.

According to this invention I provide an electrode assembly containing a needle/wire made from metallic material having high thermal and electrical conductivity, adapted to penetrate a heated body which may be living tissue, said needle/wire carrying an exposed surface to which is applied temperature indicating paint or material of known infra-red emissivity.

Said needle/wire may be assembled to insulation means which will restrict the transfer of heat to and from selected regions of said needle/wire, so as to make the temperature of the said needle/wire a valid measure of the temperature within said heated body.

Preferably an indicator element is assembled to said needle/wire, in good thermal contact thereto, conveniently to carry said temperature indicating paint and to identify the position and orientation in which said assembly is required to be placed.

Such an electrode assembly, applied to measurement of the temperature within living tissue during the course of diathermy treatment, has advantages which include simplicity, low cost, relative immunity to electromagnetic interference, and a thermal equalisation effect which takes place because said needle/wire effects a redistribution of heat along its uninsulated portion; this serves to offset uneven heating caused by local concentrations of electrical heating current.

Cooling means such as a stream of air may be directed to a said electrode assembly to provide further correction of a non-uniform heat distribution. Said stream may be interrupted while measurements of temperature take place.

In one embodiment of this invention, a needle/wire is provided with thermal insulation which is not uniformly distributed around its periphery. This is in order to restrict loss of heat occurring in any particular angular orientation relative to tissue boundaries or to an electrode pattern. Since thermal insulation also restricts electrical conduction, this arrangement has the further advantage of confining heating currents to the regions of said living tissue which are intended to be treated.

If a said electrode assembly is attached to a common guide or assembly, the said angular orientation may be readily preserved in use. Otherwise means may be needed for restraining angular rotation of the electrode assembly occurring after insertion. For this reason the said needle/wire is preferably shaped so as to possess a non-circular cross-section. A convenient form of construction comprises two closely spaced cylindrical wires, joined by a wire loop to facilitate handling.

In a further improved embodiment which serves both to restrain angular rotation and to restrict thermal and electrical conduction in particular directions, the said needle/wire comprises two parallel strands of high conductivity copper or silver wire, one of said strands being covered by an attached insulating sleeve with said sleeve designed to be oriented toward the outside of the treatment region defined by the pattern of said electrodes. This will tend to reduce loss of heat and electric current flow from said electrode assemblies into relatively cool untreated regions of said living tissue. The said high conductivity wire must serve as a mechanical location to the said insulating sleeve but need not pass continuously through it.

To illustrate a preferred embodiment of this invention with reference to figure 1, a wire of high thermal conductivity such as silver or copper is bent to comprise a loop 1 joined to two closely parallel straight extensions 2 and 3 (in a form resembling an engineering split pin known in the prior art). A disc of printed circuit material 4 comprises a conductive surface 5 which may be that of a copper sheet, laminated to an insulating sheet 6 which may be of fibreglass. Said insulating sheet prevents thermal and electrical conduction taking place directly between said copper sheet and the surface of a heated body penetrated by the said wire. The conductive face of said disc is soldered at 7 adjacent to the said wire, the soldering effecting a good thermal contact between said wire and the said conductive surface 5 of said copper sheet.

The exposed conductive surface 5 is painted with temperature indicating paint known in the prior art. A surface of said disc is further painted with coloured lacquer at 8 to identify its desired position and orientation and also its electrical connection 9 shown diagrammatically, which may be attached either to said needle/wire or to said conductive sheet.

In an alternative embodiment, of which a detail is shown in figure 2, a wire 10 corresponding to wire 2 on Figure 1 is bent at 180 degrees to enter a bored cylinder 11 made from a material which is an electrical and thermal insulator. The wire 10 is so bent that its other extremity 12 lies also within the central bored hole of cylinder 11, the axis of said cylinder 11 being thereby aligned with respect to wire 10 so as to retain said cylinder mechanically. The said cylinder 11 serves to shield wire 10 from thermal and electrical conduction (occurring to the right of said cylinder 11 as drawn) when wire 10 with attached cylinder 11 penetrate a heated body.

CLAIMS

1. An electrode assembly containing a needle/wire made from metallic material having high thermal and electrical conductivity, adapted to penetrate a heated body which may be living tissue, said needle/wire carrying an exposed surface to which is applied temperature indicating paint or material of known infra-red emissivity.

2. Apparatus according to claim 1 wherein said assembly is adapted to be connected to an output terminal of a high frequency electrical generator.

3. Apparatus according to claim 1 wherein an indicator element is attached to said needle/wire comprising a surface area of high thermal conductivity visible to an operator and also in good thermal contact with said needle/wire, said surface area capable of being coated with temperature sensitive paint or being of known infra-red emissivity, and said surface area insulated by interposed non-conducting material from the surface of said heated body.

4. Apparatus according to claim 3 where said indicator element is a plate of printed circuit material as known in the prior art, attached by soldering to said needle/wire with its plane substantially perpendicular to the axis thereof, with said surface area of high conductivity facing away from said heated body.

5. Apparatus according to claim 1 comprising a needle/wire coated with an insulating material over part of its surface in order to restrict the flow of heat and electricity between said heated body and said needle/wire and thereby make the temperature of the said needle/wire a valid measure of the temperature of a designated region within said heated body.

6. Apparatus according to claim 1 wherein said needle/wire comprises two parallel strands of wire, said strands being linked by a wire loop, in order to resist rotation about an axis parallel to said strands of wire when inserted to penetrate a said heated body.

7. Apparatus according to claim 1 wherein a cylinder of insulating material is attached to said needle/wire and maintained closely parallel to it in a common plane or helix where said needle/wire enters said heated body.

8. Apparatus constructed substantially in accordance with the attached drawings.

The Patent Office

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Application No: GB 9801315.4
Claims searched: 1-8

Examiner: David Brunt
Date of search: 17 May 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including **GB**, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): A5R (RHAP, RHCE, RHEPX), G1D (DH31A, DH31X), G1N (NENT)

Int Cl (Ed.6): A61B (17/39), A61N (1/05), G01K (11/12, 11/14, 11/16)

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2281863 A	(WALTON) see p.3 ll.16-23	1,2
Y	GB 2274334 A	(FOGARTY) see figure	1,2
Y	GB 2204874 A	(ROLLS-ROYCE) see whole document	1,2
Y	EP 0111093 A2	(GAMBRO) see p.2 ll.5-30	1,2
Y	WO 95/19142 A1	(VIDAMED) see p.7 l.23-p.8 l.4	1,2
Y	US 4971068	(SAHI) see col.3 ll.4-26 & col.5 ll.34-47	1,2
Y	US 4509532	(DEVRIES) see col.2 ll.43-47	1,2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
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